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(71)Applicant : SEIKO EPSON CORP

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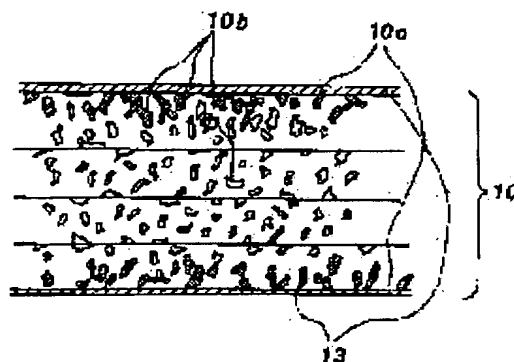
(72)Inventor : ONISHI HIROYUKI

## (54) INK-JET HEAD AND ITS MANUFACTURE

## (57)Abstract:

PURPOSE: To obtain an ink-jet head which is durable enough to spout ink for a long term without deterioration in electric insulation resistance of a piezoelectric converter and capable of stably spouting all kinds of ink such as water type ink, solvent ink, and hot-melt ink.

CONSTITUTION: Electric insulating oxide layers 13 are formed over the surfaces 10a and pores 10b of a laminated type piezoelectric converter.



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(73) 特許権者 000002369

セイコーエプソン株式会社

東京都新宿区西新宿 2 丁目 4 番 1 号

(72) 発明者 大西 弘幸

長野県諏訪市大和 3 丁目 3 番 5 号 セイ

コーエプソン株式会社内

(74) 代理人 100082566

弁理士 西川 慶治 (外 2 名)

審査官 瀧本 十良三

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(54) 【発明の名称】 インクジェットヘッド及びその製造方法

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(57) 【特許請求の範囲】

【請求項 1】 ノズル開口を有するノズル形成部材と、  
該ノズル形成部材の背後に配置された圧電変換器とを有し、  
前記圧電変換器によりインクを加圧して前記ノズル  
開口からインクを吐出させるインクジェットヘッドにお  
いて、

前記圧電変換器が、その表面に電気絶縁性を有する酸化  
物の層を備え、また前記圧電変換器の空孔に前記電気絶  
縁性を有する酸化物を充填して構成されているインクジ  
ェットヘッド。

【請求項 2】 圧電変換器の変位によりインクを加圧し  
てノズル形成部材のノズル開口からインク滴を吐出させ  
るインクジェットヘッドの製造方法において、  
前記圧電変換器に、電気絶縁性を有する酸化物の粒子を  
溶媒に分散させたゾルを付着させて含浸させる第 1 工程

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と、前記ゾルの溶媒を揮散させる第 2 工程と、を備えた  
インクジェットヘッドの製造方法。

【請求項 3】 第 1 工程、第 2 工程を複数回繰返す請求  
項 2 に記載のインクジェットヘッドの製造方法。

【発明の詳細な説明】

【0001】

【発明が属する技術分野】 本発明は、記録インクを飛翔  
させ、文字・画像を形成するインクジェット記録装置の  
インクジェットヘッドに関する。

【0002】

【従来の技術】 ノズル開口に連通する圧力発生室を加圧  
してノズル開口からインク滴を吐出させる圧力変換器  
は、特公昭63-125343号公報等にも見られるように、内  
部電極と圧電材料とを交互に積層して構成されており、  
各層の圧電材料を薄くすることで低い駆動電圧でインク

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滴を吐出させることができる。の大幅な引き下げが可能低電圧化が可能になる。

【0003】

【発明が解決しようとする課題】積層型の圧電変換器は、有機成分からなるバインダとセラミックス粉末と、銀や銀-パラジウムを主成分とする金属ペーストとを積層し、これを焼結して製造されている。このため、内部電極が銀を含むため、エレクトロマイグレーション現象により沿面放電による故障が発生しやすい。この現象は、圧電変換器がインクに直接接触が否かに係わらず、内部電極付近の湿気や、温度、さらには圧電材料の薄層化により助長される。そればかりでなく、焼結によりバインダが揮散して形成された微細な貫通孔（この孔を空孔という）を内在させることになり、内部において貫層放電が発生する虞がある。このような不都合を防止するため、特開平4-368852号公報にみられるように、圧電振動子全体に耐湿性材料で被覆することも示唆されているが、耐湿性材料等について何ら具体的な提案がなされていない。

【0004】本発明は、このような問題に鑑みてなされたものであって、その目的とするところは、圧電変換器の表面での沿面放電、及び内部での貫層放電を可及的に防止して高い信頼性で印刷することができるインクジェットヘッドを提供することである。

【0005】本発明の他の目的は、上記インクジェットヘッドの製造方法を提案することである。

【0006】

【課題を解決するための手段】このような問題を解消するため本発明においては、ノズル開口を有するノズル形成部材と、該ノズル形成部材の背後に配置された圧電変換器とを有し、前記圧電変換器によりインクを加圧して前記ノズル開口からインクを吐出させるインクジェットヘッドにおいて、前記圧電変換器が、その表面に電気絶縁性を有する酸化物の層を備え、また前記圧電変換器の空孔に前記電気絶縁性を有する酸化物を充填するようにした。

【0007】

【作用】本発明のインクジェットヘッドによれば、焼成により発生した空孔には酸化物が充填されており、また表面は酸化物により被覆されているため、圧電変換器が高い気密封止性を持ち、電気絶縁破壊が抑制され、振動特性の長期安定性が向上する。また、酸化物の高い耐熱性により加熱処理が可能となり、塗布剤に含まれる水分等を完全に排除することができ、高い絶縁性を確保することができる。

【0008】

【実施例】そこで以下に本発明の詳細を図示した実施例に基づいて説明する。図1は、本発明のインクジェットヘッドの一実施例を示すものであって、圧電変換器10は、圧電性セラミックスなどの圧電体11と導電材12

a、12b（以下、内部電極12a、12bと称す。）とを、それぞれ交互に積み重ねた多層構造体として構成されている。内部電極12aは、外部電極14aと、また内部電極12bは外部電極14bとそれぞれ電氣的導通がなされ、ベース部材15の表面に接合されている。

【0009】このように構成された圧電変換器10は、図2に示したように表面10aに電気絶縁性の酸化物層13の層13aが形成され、また表面近傍に存在する空孔10bには電気絶縁性の酸化物13bが充填されている。

【0010】このように構成された圧電変換器10は、図3に示したようにノズル開口18を備えたノズルプレート16の背面側に存在するインク17を加圧するように配置され、この状態で外部電極14aと外部電極14bとに駆動信号が印加されると、内部電極12aと内部電極12bとの間に存在する圧電体11に電界が作用して伸縮する。これにより、ノズルプレート16との間のインク17が加圧されてノズル開口18からインク滴が吐出する。

【0011】このように電界が印加された際にも、空孔に酸化物が充填され、また表面には酸化物の層が存在するため、圧電変換器10を構成する圧電体11や内部電極12a、12bが外気と確実に遮断され、絶縁破壊等の電氣的障害が確実に防止される。

【0012】次に、上述の圧電変換器の製造方法について説明する。アルミニウム、チタン、ジルコニウム等の金属酸化物やケイ素などの非金属酸化物、あるいはそれらの複合化合物を、有機溶媒を主分散溶媒としてオルガノソルを調製し、このオルガノソルを圧電変換器に塗布する。これにより圧電変換器の表面には層が、また表面近傍の空孔に浸透する。その後、80℃程度の温度により加熱して有機溶媒や、水分を揮散させて、表面に高い電気絶縁性を有する酸化物の層を、また空孔に高い電気絶縁性を有する酸化物を充填する。

【0013】（実施例1）

平均粒径が0.01μmであるSiO<sub>2</sub>とZrO<sub>2</sub>とを重量比65：35でエタノールを主成分とする分散媒に分散し、固形分20%、粘度7cP（センチポイズ）のゾルを調製する。

【0014】まず、圧力容器内に圧電変換器10と上記ゾルを収容した容器とを別々に設置し、圧力容器を減圧してから圧電変換器10をゾルに浸漬する。ついで、圧力容器内に空気を入れて、大気圧を利用して空孔にゾルを注入する。

【0015】圧力変換器10をゾルから引き上げて圧電変換器を80℃で加熱し、ゾルの溶剤を揮発させると、圧電変換器10の表面には、SiO<sub>2</sub>-ZrO<sub>2</sub>層が形成され、また空孔にSiO<sub>2</sub>-ZrO<sub>2</sub>が充填された圧力変換器が完成する。

【0016】上記浸漬操作と加熱乾燥操作を交互に繰返

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すと、例えば  $0.1 \mu\text{m}$  乃至数百  $\mu\text{m}$  程度の  $\text{SiO}_2\text{-ZrO}_2$  層を形成でき、これによりピンホールなどの塗膜欠陥が無いガス遮断の優れた圧電変換器を得ることができる。

【0017】すなわち、上記操作をそれぞれ3回繰り返して膜厚  $0.6 \mu\text{m}$  の  $\text{SiO}_2\text{-ZrO}_2$  層を形成した圧電変換器により水系染料インクを用いて耐久試験を実施したところ、500万ライン（10億ドット相当）以上安定してインク滴を吐出させることができた。

【0018】なお、塗布方法としては、圧電変換器10を上記ゾルに浸漬した後に減圧処理してもよいし、圧力操作をせずに大気圧中のみで浸漬する方法、スピスコート、ディッピングでも良い。

【0019】（実施例2）

平均粒径が  $0.05 \mu\text{m}$  であるアルミナ微粒子でイソプロパノールを主成分とする分散媒に分散し、固形分10%、粘度5cPのゾルを調製する。

【0020】圧電変換器を上記ゾルに大気圧状態で所定時間浸漬した後、引き上げて圧電変換器を  $80^\circ\text{C}$  で加熱し、溶剤を揮散させるとい工程を2回繰り返して圧電変換器の表面に膜厚  $0.5 \mu\text{m}$  のアルミナ層を形成する。

【0021】この圧電変換器により温度  $110^\circ\text{C}$  のホットメルトインクを用いて、500万ライン（10億ドット相当）以上を安定に印刷することができた。

【0022】（実施例3）

平均粒径が  $0.02 \mu\text{m}$  である  $\text{SiO}_2\text{-ZrO}_2\text{-Na}_2\text{O}$  微粒子をエタノールを主成分とする分散媒に分散し、固形分5%、粘度10cPのゾルを調製する。

【0023】まず、上述のゾルをディッピングにより圧電変換器の表面に塗布し、ついで温度  $120^\circ\text{C}$  で加熱して溶剤を揮発させるという工程を4回繰り返して、圧電変換器の表面に膜厚  $0.8 \mu\text{m}$  の  $\text{SiO}_2\text{-ZrO}_2\text{-Na}_2\text{O}$  層を形成する。

【0024】この変換器により、高沸点・低揮発性の脂

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肪族炭化水素（商品名アイソパーL、エクソン社製）に顔料を分散させたソルベントインクを用いて500万ライン（10億ドット相当）以上を安定に印刷することができた。

【0025】

【発明の効果】以上、説明したように本発明においては、インクを加圧する圧電変換器の表面に電気絶縁性を有する酸化物の層を備え、また圧電変換器の空孔に電気絶縁性を有する酸化物が充填されているので、圧電変換器を水分やゴミ等の異物の混入や汚染、外乱などから遮断して電気絶縁抵抗の低下を防止することができ、種類のインクを安定に吐出させることができる信頼性の高いインクジェットヘッドを実現することができる。

【図面の簡単な説明】

【図1】本発明のインクジェットヘッドに使用する圧電振動子の一実施例を示す斜視図である。

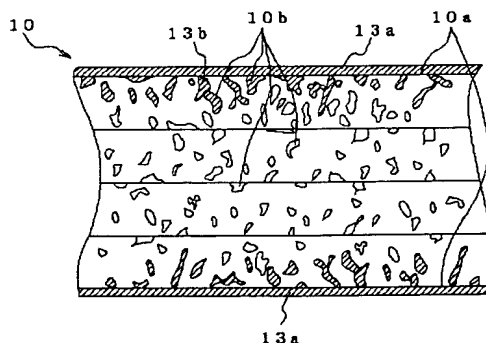
【図2】同上圧電変換器の断面を拡大して示す図である。

【図3】同上圧電振動子を使用したインクジェットヘッドの一例を示す断面図である。

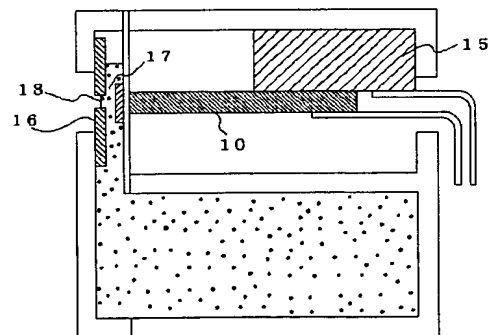
【符号の説明】

- 10 圧電変換器
- 10a 圧電変換器の表面
- 10b 圧電変換器の空孔
- 11 圧電体
- 12a 内部電極
- 12b 内部電極
- 13 酸化物層
- 14 ベース部材
- 15a 外部電極
- 15b 外部電極
- 16 ノズルプレート
- 17 インク
- 18 ノズル開口

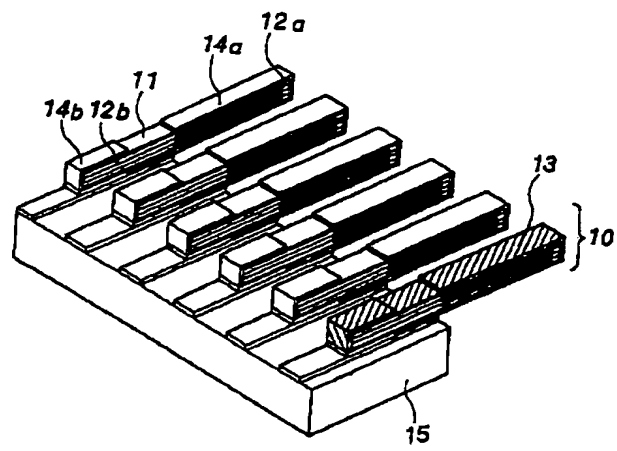
【図2】



【図3】



【図 1】



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CLAIMS

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[Claim(s)]

[Claim 1] The ink-jet head characterized by forming the oxide layer of electric insulation in the front face and hole of a laminating type piezoelectric transducer in the ink-jet head which it has [ head ] the nozzle plate which has two or more nozzle openings, and the laminating type piezoelectric transducer which has been arranged behind this nozzle plate, and which can be driven independently, and makes the record ink between a nozzle plate and a laminating type piezoelectric transducer breathe out.

[Claim 2] The manufacture method of the ink-jet head characterized by forming the oxide layer of electric insulation by having the following and applying the sol which the oxide particle distributed to the front face and hole of a laminating type piezoelectric transducer in the manufacture method of an ink-jet head of making the record ink between a nozzle plate and a laminating type piezoelectric transducer breathing out. The nozzle plate which has two or more nozzle openings. The laminating type piezoelectric transducer which has been arranged behind this nozzle plate and which can be driven independently.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention makes record ink fly and relates to the ink-jet head and its manufacture method of the ink-jet recording device which forms a character and a picture.

[0002]

[Description of the Prior Art] since ink-jet record makes the minute ink drop which is a low running cost since the regular paper recordable high-speed with easy colorization whose process is an easy non-noise since it is direct record can be used breathe out, record of high resolution is possible for it -- etc. -- it has the outstanding feature and the future attracts attention

[0003] The stability of the ink drop which flew when the ink-jet head currently indicated by JP,60-8953,B etc. vibrated conventionally so that it may displace in the direction in which a nozzle formation member and a piezoelectric transducer cross at right angles in general, and the passage between each nozzle led in a short distance is good, and even when foreign matters, such as a foam and dust, mix into ink, it has the feature that operation is normally maintainable, without these being influenced.

[0004] However, in an ink-jet head, although it is desirable for the regurgitation efficiency and the flight force of a field to an ink drop of printing speed and a quality of printed character to be large, the ink-jet head of the aforementioned structure is not enough as the amount of expansion and contraction per unit length of a piezoelectric transducer, or the amount of expansion and contraction per unit voltage, and the generating force is also small. Therefore, in order to acquire the flight force required of printing, the beam of a piezoelectric transducer was lengthened, or impression of high voltage was needed, and there was a problem that a drive circuit and the cure against electric insulation were complicated.

[0005] In order to solve such a problem, an internal electrode and a piezo electric crystal are piled up by turns, and the ink-jet head using the unified laminating type piezoelectric transducer is proposed as indicated by JP,63-125343,B etc. A laminating type piezoelectric transducer is adjusting the number of laminatings, does not drop the mechanical strength of a piezoelectric transducer, but can make small distance between layers of an internal electrode and an internal electrode as much as possible. Since the lamination of a piezo electric crystal has the effect which raises field strength, large low-battery-ization of driver voltage is attained.

[0006]

[Problem(s) to be Solved by the Invention] However, since the ink-jet head using the conventional laminating piezoelectric transducer mentioned above of interception with ink is inadequate when the laminating type piezoelectric transducer itself is directly in contact with ink or it is intercepted, it will be limited to ink with the electric insulation to be used. Therefore, since priority was given to electric insulation, it had the technical problem that it could not satisfy enough a high quality of printed character and a quick-drying one, by limiting record ink.

[0007] Especially, the metal which makes silver and silver-palladium a principal component is used for the internal-electrode material of a laminating type piezoelectric transducer, and it was easy to generate failure of the creeping discharge by the electromigration phenomenon, \*\*\*\* electric discharge, etc., and in spite of having not touched, in connection with the densification of existence of the humidity near an electrode, temperature, and the distance between internal electrodes, it had the technical problem whose piezoelectric transducer touches ink that the aforementioned phenomenon was promoted.

[0008] Moreover, since a laminating type piezoelectric transducer sinters the ceramic powder and metal paste which contained the organic component so much and is manufactured, an organic component escapes from it after sintering, and it serves as perforated space containing a detailed breakthrough (this hole is called hole). Therefore, the aforementioned phenomenon has possibility of generating also not only in the front face of a piezoelectric transducer but in the interior.

[0009] Then, the purpose of this invention solves these technical problems, makes all ink fly stably, and is to offer the ink-jet head which can attain high-speed and high definition printing and high-reliability, and its manufacture

method.

[0010]

[Means for Solving the Problem] The ink-jet head of this invention has the nozzle plate which has two or more nozzle openings, and the laminating type piezoelectric transducer which has been arranged behind this nozzle plate and which can be driven independently, and is characterized by forming the oxide layer of electric insulation in the front face and hole of a laminating type piezoelectric transducer in the ink-jet head which makes the record ink between a nozzle plate and a laminating type piezoelectric transducer breathe out.

[0011] Moreover, the manufacture method of the ink-jet head of this invention is characterized by forming the oxide layer of electric insulation by having the nozzle plate which has two or more nozzle openings, and the laminating type piezoelectric transducer which has been arranged behind this nozzle plate and which can be driven independently, and applying the sol which the oxide particle distributed to the front face and hole of a laminating type piezoelectric transducer in the manufacture method of an ink-jet head of making the record ink between a nozzle plate and a laminating type piezoelectric transducer breathing out.

[0012]

[Function] According to this invention, since the oxide layer of electric insulation is formed in a piezoelectric-transducer front face and a hole, the electric insulation of a piezoelectric transducer improves and dielectric breakdown is suppressed. Furthermore, in order to converge quickly the deck watertight luminaire by the oxide layer, damp-proof and heat-resistant improvement, and the residual vibration of a laminating piezoelectric transducer, the stability of an oscillation characteristic can also be raised.

[0013]

[Example] Drawing 1 is the tropia cross section of the important section of the ink-jet head in this invention. A piezoelectric transducer 10 is the multilayer structure which accumulated a piezo electric crystal 11 and the electric conduction material 12a and 12b (internal electrodes 12a and 12b are called hereafter.), such as piezoelectric ceramics, by turns, respectively. Furthermore, the electric conduction material 14a and 14b (the external electrodes 14a and 14b are called hereafter.) is formed in the piezoelectric transducer 10, and, as for external electrode 14a, the electric flow is made with internal-electrode 12b, respectively, as for internal-electrode 12a and external electrode 14b. As shown in drawing 3, the oxide layer 13 of electric insulation is formed in surface 10a of a piezoelectric transducer 10, and hole 10b by the method of mentioning later. moreover, the piezoelectric transducer 10 -- the base -- it is joined on the member 15

[0014] In this composition, the piezoelectric transducer 10 to which the electric field shown in drawing 2 were impressed when the electrical signal of operation was inputted into the piezoelectric transducer 10 is contracted in the direction which intersects perpendicularly with a nozzle plate 16. If this electric field are canceled, a pressure will be applied to the ink 17 between nozzle plates 16 according to the elastic stability of a piezoelectric transducer 10, and an ink drop will carry out the regurgitation from the nozzle opening 18.

[0015] The manufacture method is described below.

[0016] After applying to a piezoelectric-transducer front face fundamentally the organosol which used the organic solvent as the primary-dispersion solvent for nonmetallic oxides, such as metallic oxides, such as aluminum, titanium, and a zirconium, and silicon, or those conjugated compounds as a dispersoid, the oxide layer of electric insulation is formed in a piezoelectric-transducer front face and a hole by evaporating and drying a solvent.

(Example 1)

The SiO<sub>2</sub>-ZrO double quantitative ratio 65:35 used for the front face and hole of a piezoelectric transducer 10 20% of solid contents which distributed ethanol to the dispersion medium made into a principal component, viscosity 7cP (centipoise), and the sol of 0.01 micrometers of mean particle diameters as an example 1.

[0017] First, a piezoelectric transducer 10 and the above-mentioned sol are separately installed in a pressurized container. The inside of a pressurized container is decompressed gradually, it goes, and a piezoelectric transducer 10 is immersed in a sol in the state of equilibrium pressure. And air is put in in a pressurized container, using atmospheric pressure, a hole is sealed and covering and restoration are carried out to the front face of a piezoelectric transducer 10.

[0018] The method and spin coat which are immersed only in atmospheric pressure, without carrying out reduced pressure processing of the piezoelectric transducer 10 to others after being immersed in the above-mentioned sol, and carrying out pressure operation to the method of application, and dipping are sufficient.

[0019] Next, desolventization processing of a sol is carried out. The solvent of the sol which heated and filled up the piezoelectric transducer with 80 degrees C is volatilized. SiO<sub>2</sub>-ZrO two-layer is formed in the front face of a piezoelectric transducer 10 of this.

[0020] If the above-mentioned immersing operation and stoving operation are repeated by turns, paint film defects, such as a pinhole, are lost, and the gas interception nature of a piezoelectric transducer 10 can improve further, and can obtain desired thickness (0.1 micrometers - hundreds of micrometers).



[0021] As a result of making drainage system color ink breathe out by this example using the head which repeated the above-mentioned operation 3 times, insulation-ized the front face of a piezoelectric transducer by 0.6-micrometer SiO<sub>2</sub>-ZrO two-layer, and was manufactured, the ink regurgitation by which it was stabilized more than 5 million line (1 billion dots) was possible.

[0022] (Example 2) The alumina particle used for the front face and hole of a piezoelectric transducer 10 10% of solid contents which distributed the isopropanol to the dispersion medium made into a principal component, viscosity 5cP (centipoise), and the alumina sol of 0.05 micrometers of mean particle diameters as an example 2.

[0023] First, it was immersed only in atmospheric pressure, without carrying out pressure operation, the piezoelectric transducer was heated at 80 degrees C, the solvent was volatilized, and the alumina layer was formed in the piezoelectric-transducer front face.

[0024] As a result of repeating the above-mentioned operation twice, insulation-izing the front face of thick \*\*\*\*\* in a 0.5-micrometer alumina layer and making the hot-melt ink always heated at 110 degrees C breathe out using the manufactured head, the ink regurgitation by which it was stabilized more than 5 million line (1 billion dots) was possible.

[0025] (Example 3) The SiO<sub>2</sub>-ZrO<sub>2</sub>-Na<sub>2</sub>O particle used for the front face and hole of a piezoelectric transducer 10 5% of solid contents which distributed ethanol to the dispersion medium made into a principal component, viscosity 10c (centipoise), and the sol of 0.02 micrometers of mean particle diameters as an example 3.

[0026] First, the above-mentioned sol was applied on the surface of the piezoelectric transducer by dipping, it heated at 120 degrees C, the solvent was volatilized, and the SiO<sub>2</sub>-ZrO<sub>2</sub>-Na<sub>2</sub>O layer was formed in the thick \*\*\*\*\* front face.

[0027] As a result of repeating the above-mentioned operation 4 times, insulation-izing the front face of thick \*\*\*\*\* by 0.8-micrometer SiO<sub>2</sub>-ZrO<sub>2</sub>-Na<sub>2</sub>O layer and making the solvent ink which made the aliphatic hydrocarbon (tradename Isopar L, Exxon company make) of a high-boiling point and low volatility distribute a pigment breathe out using the manufactured head, the ink regurgitation by which it was stabilized more than 5 million line (1 billion dots) was possible.

[0028]

[Effect of the Invention] According to this invention, it has the nozzle plate which has two or more nozzle openings, and the laminating type piezoelectric transducer which has been arranged behind this nozzle plate and which can be driven independently. In the ink-jet head which makes the record ink between a nozzle plate and a laminating type piezoelectric transducer breathe out By forming the oxide layer of electric insulation in the front face and hole of a laminating type piezoelectric transducer, it has the effect that a piezoelectric transducer can be perfectly intercepted from mixing of foreign matters, such as moisture and dust, contamination, disturbance, etc.

[0029] Moreover, there is no electric insulation resistance degradation of a piezoelectric transducer, and it also has the effect of making possible \*\*\*\*\* which has endurance in a long period of time.

[0030] Moreover, since it can be stabilized and all the ink of drainage system ink, solvent ink, and hot-melt ink can be made to breathe out, it also has the effect that a quantity quality of printed character and a high definition ink-jet head can be offered.

[0031] Furthermore, it also has the effect of offering the piezoelectric transducer excellent in thermal resistance.

[0032] Furthermore, since the residual stress of a piezoelectric transducer can be converged quickly, it also has the effect which raises the stability of an oscillation characteristic by leaps and bounds.

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[Translation done.]

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the cross-section perspective diagram of the important section of the ink-jet head by this invention.

[Drawing 2] It is the cross section of the ink-jet head of this invention.

[Drawing 3] It is a laminating type piezoelectric-transducer partial expanded sectional view.

[Description of Notations]

- 10 ..... Piezoelectric transducer
- 10a ..... Front face of a piezoelectric transducer
- 10b ..... Hole of a piezoelectric transducer
- 11 ..... Piezo electric crystal
- 12a ..... Internal electrode
- 12b ..... Internal electrode
- 13 ..... Oxide layer
- 14 ..... the base -- a member
- 15a ..... External electrode
- 15b ..... External electrode
- 16 ..... Nozzle plate
- 17 ..... Ink
- 18 .... Nozzle opening

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[Translation done.]